illustration. They are well represented by the dotted curve, which is of the same form as the curve for 1899, immediately above it.

If the forms of the velocity-curves of the binary system are the same for 1896 and 1899, the present velocity of the center of gravity of the binary system differs about $6\frac{1}{2}^{km}$ from its value in 1896.

The observations were made with the Mills spectrograph attached to the 36-inch telescope.

W. W. CAMPBELL.

1899, September 30.

PHOTOGRAPHIC EFFICIENCY OF THE CROSSLEY REFLECTOR.

The reflecting telescope has been so little used in this country, since the time of HENRY DRAPER, that a few notes on the photographic efficiency of the Crossley reflector may be of interest to American readers.

The Crossley dome is built on the farther end of a long rocky spur, which extends from the principal summit of Mt. Hamilton toward the south, and is within a few minutes' walk (or climb) of the main Observatory. The mirror, which has a very fine figure, has an aperture of three feet, and a focal length of seventeen feet six inches. The mounting, as compared with the beautifully mounted large refractors of the Observatory, is undoubtedly a rude piece of mechanism, but with sufficient experience of its numerous idiosyncrasies, the observer can obtain negatives with exposures of four hours' duration, with only an occasional failure.

At present the Crossley telescope is being used for photographic observations of nebulæ. For such work the summer months at Mt. Hamilton present almost ideal conditions. The sky is continuously and often brilliantly clear, while the dryness and purity of the air are such that the silvered surfaces retain their brilliancy without any care on the part of the observer. Within the last week, however, the smoke from forest fires (from which there seems to be no escape in even the remotest corners of the earth) has greatly dulled the brightness of the sky, and has interfered most annoyingly with the photographic work. In the winter months, on the other hand, the conditions are generally bad, on account of storms, snow, fog, or dampness; yet there are many nights, between the spells of bad weather, on which the telescope can be used.

To one who, like myself, has always worked with refracting telescopes, the photographic power of a large reflector is surprising. In this respect, the Crossley reflector does not, of course, surpass any other reflecting telescope of like dimensions, but its photographic "rapidity" is certainly very considerably greater than that of a refracting telescope of the same angular aperture. This is due to the fact that the silvered surfaces absorb less of the chemically active light than the glass lenses of a refractor, and it is noteworthy that this superiority of the reflector becomes more pronounced the finer the atmospheric conditions under which the two classes of instruments are compared. On one of the fine nights which I have mentioned, when the Milky Way shines with astonishing splendor and the whole heavens look phosphorescent, the photographic activity of the reflector is remarkably increased. But the performance of the refractor is not greatly changed, for the reason that the short light-waves, which are transmitted more abundantly by the unusually clear air, are in any case strongly absorbed by glass.

To illustrate the photographic rapidity of the Crossley telescope, I give the following examples of exposure-times in which well-known nebulæ have been photographed:—

The Ring nebula in *Lyra* has been photographed on several occasions, and the results are described in another part of the present number of the *Publications*. It will be seen that the best general representation of the nebula was obtained with an exposure of ten minutes. On this plate the stars are perfectly round and very small. The disc of the central star of the nebula has a diameter of 3″.5; that of the smallest stars shown does not exceed 1″.5. On the same plate is a double star (not resolved) the equal components of which are about 2″ apart, while their magnitude is not less than 17 or 18. It will hardly be observed visually. The central star, which has a visual magnitude of 15.4, according to BURNHAM, gave a distinct image in one minute.

Photographs of small planetary nebulæ have been made, not only for the purpose of ascertaining the exposure-times required for such objects, but to see what amount of detail can be shown in a surface of such small dimensions. With regard to the latter purpose, it was found that a large amount of detail was shown, but that visual observation with the 36-inch refractor was more satisfactory than photographic observations with the reflector.

In the case of the small but remarkable planetary nebula G. C. 4628 (26″× 16″), the best general picture was obtained in two minutes, while the "ansæ," extending outward from and connected with the main nebula, were well shown in ten minutes.

Another planetary nebula which has been photographed is G. C. 4964. Eight images were obtained on the same plate by slightly changing the position of the plate-holder between the exposures, which ranged from two minutes to one second. The images which received exposures of one minute, thirty seconds, and twenty seconds respectively, were the best. A weak image, in which the central star was just visible, was produced in two seconds, and a bare trace of the nebula was visible at the place where the exposure was one second.

The planetary nebula in *Draco*, G. C. 4373, has also been photographed, with quite similar results; and the small nebula discovered by Professor BARNARD near the star *Merope* is distinctly shown on a negative of the *Pleiades* which was exposed for thirty seconds.

The photographic power of the reflector which is illustrated in the foregoing examples is very advantageous in the case of objects which are of very unequal brightness, as a very full light-action, and consequently softening of contrasts, is obtained with a comparatively short exposure. If, for instance, a plate is exposed for ten minutes to such an object as the great cluster in *Hercules*, and rather strongly developed, a negative is obtained which shows very distinctly all the brighter stars. If the plate is exposed for two hours, and is then very lightly developed, the brighter stars appear much as before, but the swarms of minute stars, to which a globular cluster seems to owe its nebulous aspect, also appear on the plate, so that the photograph closely represents the appearance of the cluster as seen in a large telescope. On a photograph of the cluster in *Hercules*, made with the Crossley reflector on July 13th, with an exposure of two hours, over 5,400 stars were counted within the limits of the cluster. The average diameter of a star disc is 3″.5. A discussion of the distribution of stars in the cluster, as shown by this photograph, has been made by Mr. PALMER.

With exposures of four hours, stars and nebulæ are photographed which are far beyond the range of the 36-inch refractor. On one plate (3¼ × 4¼ in.) sixteen new nebulæ were found. It would be easy with this instrument greatly to

increase the number of known nebulæ; but the discovery of new nebulæ, all of which would necessarily be faint, seems to be much less important than the gain of further information about nebulæ already known. For this reason no search has been made for new objects, though a catalogue will be made in due time of those which have been found in the course of other investigations.

J. E. K.

Comet Notes.

Since its rediscovery by Mr. Perrine on the morning of June 11th,* Holmes's Comet has been regularly observed here, but, so far as is known at present, it has not been seen elsewhere. The rediscovery position enabled Mr. Zwiers to correct his search ephemeris very satisfactorily. Five observations secured by the writer between August 11th and September 9th give average residuals of only $+ 0^s.66$ in R. A. and $+ 9''.2$ in Decl. (O. — C.) to the revised ephemeris.

The comet on the last-named date was still very faint, not as bright as a fourteenth-magnitude star, and showed only a slight central condensation, no true nucleus. Unless it exhibits some of the unexpected light changes that made its former apparition so remarkable, it is likely to remain beyond the reach of all but the most powerful telescopes.

Comet Tempel II has also been observed regularly here since its rediscovery on May 6th of the present year. At first very faint, it became bright enough to be an easy object in a small telescope in the latter part of July. It is now losing light rapidly; but on the night of September 26th it was still readily visible in the 3½-inch finder of the 12-inch telescope, being about as bright as a tenth-magnitude star. The nucleus, though now quite faint, — about thirteenth-magnitude — is still clearly marked. The comet reached its greatest southern Declination about the 11th of September, and is now moving north and east. It will, therefore, remain in good position for observation for some months to come.

R. G. Aitken.

September 27, 1899.

Note on the Seeing at Mt. Hamilton.

While in the East, during the present summer, I met several astronomers who referred to the good seeing at Mt. Hamilton, as

*See these *Publications*, No. 68, p. 134.